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FOR

**RIGHTS ENFORCEMENT AND USAGE REPORTING
ON A CLIENT DEVICE**

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RIGHTS ENFORCEMENT AND USAGE REPORTING ON A CLIENT DEVICE

FIELD OF THE INVENTION

5 The present invention relates to the field of electronic content management. More specifically, the present invention relates to rights enforcement and usage reporting for content on a client device.

BACKGROUND

10 Electronic content can include a wide variety of audio and/or video presentations, such as music, dialogue, still pictures, movies, and the like. A client device can include a wide variety of electronic devices, such as an MP3 player, a personal data assistant (PDA), a cellular phone, and the like. Rights enforcement involves defining how content can be used on a client device. For instance, rights
15 information associated with a piece of content may permit rendering the content, but not copying or distributing the content.

 Rights information is often closely tied to usage information. For instance, rights information may define that a piece of content can be played a particular number of times or for a certain duration. In which case, the content's usage may
20 be tracked so that the rights limitation can be enforced. Similarly, a variety of business models can be designed around usage. For instance, with a pay-per-play business model, a user or distributor may pay royalties or license fees based on the number or duration of plays. In which case, the usage information may need to be reported from the client device to a server device.

25 In order to enforce content rights, the rights and/or usage information needs to be protected in some way. If the information is not protected, a user could, for instance, modify the information to improperly grant himself or herself additional rights or reset the number of plays. Protecting rights information usually involves encrypting the rights information. As long as the rights information is encrypted, the
30 information is unreadable. Encryption, however, relies on secret keys, making encryption only as secure as the security measures surrounding the code.

Security of usage reporting is often handled in one of two ways. In one approach, the client device can perform the encryption and decryption itself. In which case, the client device usually needs an application program interface (API) to manage communications with an external device. For example, if a client device
5 stores the rights and/or usage information in encrypted form, a server device may need to establish communications with the client device through an API. The API may be able to receive and process a variety of requests from the server device. In response to a request to report how many times a particular piece of content has been played, the client device may decrypt the usage information and deliver it to
10 the server through the API in a format that the server device can understand.

Many client devices, however, are intended to be quite simple and inexpensive, lacking the resources to provide an API that can manage content and external communications, which leads to the second commonly used security approach. These simple client devices often rely on an external device, such as a
15 server, to provide security of usage reporting. Unfortunately, externally managed security is ripe for abuse. That is, when the secret, or cryptographic key, is known outside the client device, a persistent user is likely to be able to find it.

BRIEF DESCRIPTION OF DRAWINGS

20 Examples of the present invention are illustrated in the accompanying drawings. The accompanying drawings, however, do not limit the scope of the present invention. Similar references in the drawings indicate similar elements.

Figure 1 illustrates one embodiment of a data structure.

Figure 2 illustrates one embodiment of a client device.

25 Figures 3A and 3B illustrate one embodiment of the present invention from the perspective of a client device.

Figure 4 illustrates one embodiment of the present invention from the perspective of a server device.

Figure 5 illustrates one embodiment of a generic hardware system.

30 Figure 6 illustrates one embodiment of a machine-readable medium to store executable instructions for embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, those skilled in the art will understand that the present invention may be practiced without these specific details, that the present invention is not limited to the depicted embodiments, and that the present invention may be practiced in a variety of alternative embodiments. In other instances, well known methods, procedures, components, and circuits have not been described in detail.

Parts of the description will be presented using terminology commonly employed by those skilled in the art to convey the substance of their work to others skilled in the art. Also, parts of the description will be presented in terms of operations performed through the execution of programming instructions. As well understood by those skilled in the art, these operations often take the form of electrical, magnetic, or optical signals capable of being stored, transferred, combined, and otherwise manipulated through, for instance, electrical components.

Various operations will be described as multiple discrete steps performed in turn in a manner that is helpful for understanding the present invention. However, the order of description should not be construed as to imply that these operations are necessarily performed in the order they are presented, nor even order dependent. Lastly, repeated usage of the phrase "in one embodiment" does not necessarily refer to the same embodiment, although it may.

Embodiments of the present invention can store rights and/or usage information in clear form on a client device while still providing security for the content and integrity for the rights/usage information. Storing the information in clear form can greatly simplify rights enforcement and/or usage reporting because the information does not need to be decrypted before it can be read or used either on the client device or by an external device. Security and integrity can be provided on the client device by using a device key that is externally inaccessible from the client device, reducing or eliminating the need to depend on externally known secrets. For

example, a client device, such as an MP3 player or PDA, often includes a hardware key embedded within the device. The hardware key can be used within the device by embodiments of the present invention, but, because the key is usually not accessible through any external data paths, the key can be externally inaccessible and quite
5 secure.

Figure 1 illustrates one embodiment of the present invention in the form of a data structure stored on a client device. Data structure 100 includes license 110, external integrity hash 120, and internal security block 130. License 110 can include rights information 112, usage information 114, and any other information associated
10 with a piece of content (not shown) stored on the client device. License 110 can be stored in clear form 116. That is, license 110 need not be encrypted so it can be read using any device that can read the memory of the client device. In other words, usage reporting can be as simple as reading usage information 114 from the client's memory. For instance, each time a user downloads new content or renews a license,
15 the server can read the usage information.

External security hash 120 can be a hash of license 110 in combination with external secret 122. A hash is a mathematical compression of a block of data. Virtually any change to the block of data will result in a different hash. So, by comparing two hashes of the block of data, it is possible to determine, to a
20 probabilistic certainty, whether or not the data has been changed between hashes. In other words, a hash can be used to test the integrity of a block data and determine whether or not the data has been tampered with.

External secret 122 can be a number of bits or bytes of data that are appended, or otherwise combined, with license 110 prior to generating hash 120.
25 Without knowing secret 122, it is virtually impossible to recreate license 110 or secret 122 from hash 120. In which case, hash 120 is often referred as a one-way hash. Any number of hash algorithms can be used to generate hash 120, including HMAC-SHA1 (Hash Message Authentication Code - Secure Hash Algorithm) or HMAC-MD5 (HMAC - Message Digest 5).

30 Like license 110, external integrity hash 120 can be stored in clear form 116 so that a device having access to secret 122 can use hash 120 to detect tampering with

license 110. For example, since license 110 can be stored in clear form 116, a mildly sophisticated user may find a way to read and modify rights information 112 and/or usage information 114. However, without secret 122, the user will not be able to correctly regenerate hash 120. An external device that reads license 110, and knows
5 secret 122, can compute the hash of the combination and compare it to hash 120 from data structure 100. If the hashes do not match, the tampering can be detected.

In order to use hash 120 to test the integrity of license 110, external secret 122 is known external to the client device. Any of a variety of approaches can be used to try to maintain the security of secret 122, but, unfortunately, any secret known outside
10 the client device is likely to be vulnerable. A sophisticated and determined user is likely to gain access to secret 122 eventually. But, even if hash 120 is compromised, the illustrated embodiment includes a second layer of security and integrity that does not rely on an externally known secret, namely internal security block 130.

Internal security block 130 uses device key 132 to encrypt the contents of the
15 block and store the block in encrypted form 138. Device key 132 is intended to be externally inaccessible from the client device. Any number of cryptographic techniques can be used for the encryption. In one embodiment, dedicated and trusted cryptographic hardware can be used, where the cryptographic hardware itself is also externally inaccessible.

In the illustrated embodiment, internal security block 130 includes both content
20 key 136 and internal security hash 134. Internal security hash 134 can be a one-way hash of a combination of license 110, external integrity hash 120, and device key 132. As with external integrity hash 120, internal security hash 134 can be used to test the integrity of license 110. However, as long as key 132 is only known on the
25 client device, hash 134 can only be calculated and used on the client device.

Content key 136 is a cryptographic key that can be used to decrypt the content. That is, the content associated with license 110 can be stored on the client device in encrypted form. The content cannot be used without first decrypting content
30 key 136 from block 130. For example, before playing the content, the client device can check license 110 to make sure the rights allow the content to be play and/or make sure a usage limit has not been reached. If the rights are satisfied, the client

can compute a hash and compare it to internal integrity hash 134 to test for tampering. Assuming no tampering, the client can decrypt content key 136, play the content using the decryption key, and update usage information 114. And, of course, after updating usage information 114, the client can recalculate, re-encrypt, and
5 restore hash 134, and possibly recalculate and restore hash 120.

If, on the other hand, tampering is detected, the client can disable the content, either through some positive action, such as erasing the content, or through some passive action, such as not decrypting content key 136. The client device could also record the tampering event in, for instance, license 110 where it will be externally
10 accessible.

So, even if a user manages to tamper with license 110, and manages to find external secret 122 to correspondingly update external integrity hash 120, internal integrity hash 134 will most likely render the content unusable on the client device. In other words, a user may be able to change usage reporting information 114 for
15 external reporting, but, by doing so, the user will lose access to the associated content.

The embodiment of Figure 1 includes a number of implementation-specific details. In alternate embodiments, the data structure could be arranged in any number of ways, divided among any number of memory devices, and the like.
20 Alternate embodiments may not include all of the illustrated components, may include additional components, and may combine/separate one or more components. For instance, external integrity hash 120 may not be included at all, may be a hash of just rights information 112 or usage information 114, or may also be encrypted using the same or a different external secret. Similarly, internal integrity hash 134 may not be
25 encrypted, and may be a hash of just one or more of rights information 112 and usage information 114. In yet another embodiment, external integrity hash 120 may be stored externally, for instance on a server device that also stores secret 122.

Figure 2 illustrates one embodiment of a client device 200 that can use a data structure, such as data structure 100 from Figure 1, to manage content. Client device
30 200 could be any of a number of devices, including an MP3 player, a personal data assistant, or a cellular phone. Client device 200 includes a register 210, a memory

220, an input/output (I/O) port 230, trusted hardware 240, and a user interface 260. Both register 210 and trusted hardware 240 are externally inaccessible from client device 200. That is, no external I/O path connects to either register 210 or hardware 240.

5 Register 210 stores device key 132 from Figure 1. Memory 220 stores external secret 122 and data structure 100 from Figure 1, as well as content 222. I/O port 230 makes memory 220 externally accessible. That is, any number of devices may be able to store and read information from memory 220. User interface 260 may include, for instance, a viewing screen, speaker(s), headphone port, buttons,
10 switches, and the like.

 Trusted hardware 240 includes hash circuit 242, crypto circuit 244, tracking circuit 246, and comparator 248. Trusted hardware 240 could be, for instance, an application specific integrated circuit (ASIC), a programmable gate array, a digital signal processor (DSP), a microprocessor, or any combination thereof that can
15 provide the desired functionality.

 Trusted hardware 240 has access to both register 210 and memory 220. Hash circuit 242 can be used to generate hashes 120 and/or 134 in data structure 100 using device key 132 from register 210 and/or external secret 122 from memory 220. Crypto circuit 244 can be used to generate the encrypted form 138 of internal
20 security block 130 using device key 132. Tracking circuit 246 can be used to track usage of content 222 and update usage information 114. Comparator 248 can be used to compare newly generated hashes to hashes 120 and/or 134 to detect tampering.

 Content controller 250 can control user access to content 222 through user
25 interface 260 by, for instance, initiating hash circuit 242 when a play command is received and disabling the content if comparator 248 detects tampering.

 The embodiment of Figure 2 includes a number of implementation-specific details. Alternate embodiments may not include all of the illustrated components, may include additional components, and may combine/separate one or more
30 components. For instance, other embodiments may store multiple pieces of content and associated rights data on the client device. And, rather than or in addition to an

I/O port to download secret 122, content 222, and/or various parts of data structure 100, these data items could be installed using a removable storage medium, such a disk, cartridge, and/or memory stick. In these embodiments, memory 220 could be at least partially located on the removable storage medium.

5 Figures 3A and 3B illustrate one embodiment of the present invention from the perspective of a client device. At 310, the client obtains a first integrity hash. This first hash could be a hash of rights and/or usage information in combination with an external secret, or key. The external key could be received from a server and then used on the client device itself to generate the hash. Alternatively, the hash could be
10 generated on an external device using the key and then the hash could be downloaded or installed on the client device. In the later situation, the external key may also be downloaded to the client device so that the client device can regenerate the hash as usage information changes.

 At 320, the client device obtains a second integrity hash. This second hash
15 could also be a hash of rights and/or usage information in combination with a key. The key could be the same external key used for the first hash, or it could be a different external key, or it could be the internal device key. In the case of an external key, the client device could receive the key and generate the second hash itself, or the second hash could be generated externally and downloaded or installed on the
20 client, possibly along with the external key. In the case of the internal device key, the client device can generate the second hash internally.

 At 330, the client device encrypts the second integrity hash using the internal secret, the device key in this example. At 340, the client device stores the rights and/or usage information, and the first integrity hash, in a clear form. The client
25 device stores the second integrity hash in an encrypted form at 350. In addition to storing the encrypted integrity hash, the client also encrypts a content key using the device key at 360 and stores the encrypted content key at 365.

 In response to a usage request for the content associated with the content key, the client device generates a validation hash of the rights and/or usage information at
30 370. The validation hash is for comparison with the second hash, so the same set of data used to generate the second hash is used to generate the validation hash.

At 375, the client device uses the device key to decrypt the second hash, and, at 380, the client device compares the validation hash to the second hash. If the hashes match, no tampering is detected and the content may be accessed. At 385, however, if tampering is detected, the content is disabled. Disabling the content may include erasing the content from the client's memory, disabling decryption of the content, or the like.

At 390, the client device tracks usage and updates the usage information with any changes in usage. For example, the client device may record the number of times the content has been played, what sections of the content have been played, how long the content or section of the content have been played, and the like. Usage tracking may also include making a record of any tampering.

Assuming the usage information is updated, the client device may update one or both of the hashes as well at 395. That is, assuming the hashes include the usage information, the client device will likely need to replace the hashes after any update. The first hash can be regenerated and restored. The second hash can be regenerated, re-encrypted, and restored.

Figure 4 illustrates one embodiment of the present invention from the perspective of a server device. At 410, the server device reads rights and/or usage information, as well as a first integrity hash, from a client device in clear form. At 420, the server generates a validation hash using the same set of data used to generate the first integrity hash. That is, if the first integrity hash included both the rights and usage information, then the validation hash does too. The server also uses the same external key to generate the validation hash. At 430, the server compares the validation hash to the first integrity hash to detect tampering with the rights and/or usage information.

Figures 3 and 4 includes a number of implementation-specific details. Alternate embodiments may not include all of the illustrated components, may include additional components, may combine/separate one or more components, and may arrange the components in a different order.

Figure 5 illustrates one embodiment of a generic hardware system intended to represent a broad category of computer systems such as personal computers,

workstations, and/or embedded systems. In the illustrated embodiment, the hardware system includes processor 510 coupled to high speed bus 505, which is coupled to input/output (I/O) bus 515 through bus bridge 530. Temporary memory 520 is coupled to bus 505. Permanent memory 540 is coupled to bus 515. I/O device(s) 550 is also coupled to bus 515. I/O device(s) 550 may include a display device, a keyboard, one or more external network interfaces, etc.

Certain embodiments may include additional components, may not require all of the above components, or may combine one or more components. For instance, temporary memory 520 may be on-chip with processor 510. Alternately, permanent memory 540 may be eliminated and temporary memory 520 may be replaced with an electrically erasable programmable read only memory (EEPROM), wherein software routines are executed in place from the EEPROM. Some implementations may employ a single bus, to which all of the components are coupled, or one or more additional buses and bus bridges to which various additional components can be coupled. Similarly, a variety of alternate internal networks could be used including, for instance, an internal network based on a high speed system bus with a memory controller hub and an I/O controller hub. Additional components may include additional processors, a CD ROM drive, additional memories, and other peripheral components known in the art.

In one embodiment, the present invention, as described above, could be implemented using one or more hardware systems such as the hardware system of Figure 5. Where more than one computer is used, the systems can be coupled to communicate over an external network, such as a local area network (LAN), an internet protocol (IP) network, etc. In one embodiment, the present invention as described above may be implemented as software routines executed by one or more execution units within the computer(s). For a given computer, the software routines can be stored on a storage device, such as permanent memory 540.

Alternately, as shown in Figure 6, the software routines can be machine executable instructions 610 stored using any machine readable storage medium 620, such as a diskette, CD-ROM, magnetic tape, digital video or versatile disk (DVD), laser disk, ROM, Flash memory, etc. The series of instructions need not be

stored locally, and could be received from a remote storage device, such as a server on a network, a CD ROM device, a floppy disk, etc., through, for instance, I/O device(s) 550 of Figure 5.

From whatever source, the instructions may be copied from the storage
5 device into temporary memory 520 and then accessed and executed by processor 510. In one implementation, these software routines are written in the C programming language. It is to be appreciated, however, that these routines may be implemented in any of a wide variety of programming languages.

In alternate embodiments, the present invention as described above may be
10 implemented in discrete hardware or firmware. For example, one or more application specific integrated circuits (ASICs) could be programmed with one or more of the above described functions of the present invention. In another example, one or more functions of the present invention could be implemented in one or more ASICs on additional circuit boards and the circuit boards could be inserted into the
15 computer(s) described above. In another example, field programmable gate arrays (FPGAs) or static programmable gate arrays (SPGA) could be used to implement one or more functions of the present invention. In yet another example, a combination of hardware and software could be used to implement one or more functions of the present invention.

20 Thus, rights enforcement and usage reporting for content on a client device is described. Whereas many alterations and modifications of the present invention will be comprehended by a person skilled in the art after having read the foregoing description, it is to be understood that the particular embodiments shown and described by way of illustration are in no way intended to be considered limiting.
25 Therefore, references to details of particular embodiments are not intended to limit the scope of the claims.